APPLIED SCIENCE

INCORPORATED WITH

TRANSACTIONS *of the* UNIVERSITY *of* TORONTO ENGINEERING SOCIETY

Vol. VIII - New Series

May, 1913 to April, 1914

133514
24/7/14

PUBLISHED BY
THE UNIVERSITY OF TORONTO ENGINEERING SOCIETY
ENGINEERING BUILDING
UNIVERSITY OF TORONTO, CANADA

Applied Science

INCORPORATED WITH

TRANSACTIONS OF THE UNIVERSITY OF TORONTO ENGINEERING SOCIETY

Old Series Vol. 26 TORONTO, JAN. 1914 New Series Vol. VIII. No. 9

EVOLUTION IN THE ART OF BUILDING*

H. F. Ballantyne, B.A.Sc., '93

A correct understanding of the development of the art of building has been greatly helped by the discovery that it was the result of a slow growth or evolution. The works of architecture as we find them particularly in the older countries of Europe are the resultant of many influences, and are an expression of the historical antecedents, the intellectual, moral and material conditions of the people and of the religious beliefs of the epoch in which they belong.

In some departments evolution is comparatively rapid. We have all seen illustrations of the railway passenger train of less than one hundred years ago, with its crude locomotive and stage coach passenger cars. Compare this with the modern steam locomotive, and the sturdy, handsome and luxuriously equipped passenger coaches which are attached to it.

The evolution of the modern automobile has taken place before our very eyes. The horse carriage of twenty years ago with the driving mechanism under the rear seat, is replaced by a car of entirely different construction, with the machinery placed forward where it causes least annoyance and is most readily accessible. And not only is much attention paid to comfort and engine efficiency, but this machine has become a thing of beauty, a work of art.

Evolution in architecture is not of this rapid kind, but our present knowledge of the art of building is the result of the experience of the race from the earliest time; in thinking of the work of the architect, for the best results, we must broaden our horizon and be prepared to pass in review the results of experiments of the architects and builders of many generations past, for it is to these the modern architect turns for data and inspiration. And necessarily so, for though in many avenues of research, laboratory experiments and experiments on a small scale may be made, with the architect, beyond the making of models chiefly for artistic purposes, the only way to experiment is to erect the building and by actual use determine its suitability and artistic worth. This method is slow and very

*Read before the Engineering Society on January 20th, 1914

expensive. We are, therefore, compelled more than in most lines to rely upon the actual experience of others in times both past and present.

The art of building in its best sense, due to its very nature, is difficult to fully understand and appreciate, and the architect devoting his entire time and attention to his occupation must be a man of broad education, culture and experience to make even moderately good use of his opportunities. I will, therefore, in the time at my disposal, try to put before you briefly the problems that confront the architect and explain in a limited manner why he turns out such work as we are accustomed to see.

The quality of the work done by the average architect in very large measure depends on local conditions, and in a new country such conditions are not favorable to good architecture. Association with and opportunity to study and become familiar with good examples, either new or old, are not present. The pioneer must, almost of necessity, be a man able to meet the sterner tasks of life, a man seeking to establish himself and gain a livelihood. His knowledge of art is slight; he does not understand it, and time, inclination or opportunity to gain such knowledge with a sympathetic appreciation of the requirements and niceties of art are not ordinarily part of his problem.

In matters of art and architecture the conditions in the early settlements along the Atlantic seaboard of the present United States were more favorable than in Canada. The settlers in these early colonies were, many of them, seekers after civil and religious liberty rather than material gain, while in the land from which they came, in their day, a knowledge of architecture was part of a gentleman's education. As a result, throughout the eastern states are found many buildings of the so-called "Colonial" or Georgian period, of great interest and merit.

In Canada it has been different, settled for the most part at a later date, when the interest in architecture was not general and by people without much regard for art, early examples of good architecture are few.

But, as a country becomes more thickly settled, and the people more firmly established and well to do, more time is devoted to education and travel, the isolated, provincial point of view is lost and the new nation falls into line with the older nations and takes its place in arts and letters.

The great periods of activity in art and architecture have been times of prosperity and wealth when people were filled with the buoyant optimism and self confidence which does things. Canada has already reached such a period, the true pioneering days are largely past, great wealth has been amassed, and what is of almost equal importance, a good credit reputation has been established. The demand for good architecture exists, and schools for the training of architects to meet the demand have been established.

Canada having once started, should make rapid progress, for in the United States, where conditions in the not distant past

were similar, much of the experimental work has been done; by taking advantage of this experience, as Canada is now doing, aided by the general advance all along the line, this country should be well abreast with the best in the very near future.

Present day architecture involves many problems which did not confront civilization prior to the modern era.

In the olden days the requirements for convenience and comfort were simple, if not primitive, the variety in materials of construction was limited for the most part to those to be obtained locally, while the labor conditions were much more settled, the practice of the arts and trades was hereditary, being handed down from father to son for generations. A man, too, was expected to continue in the occupation of his fathers, and in Rome, for a time at least, a man was not permitted to change either his occupation of his place of residence. Trade guilds and other organizations also tended to foster skill and pride in the practice of the arts and trades; the workmen and the apprentices were closely associated with their masters, and the architect or man charged with directing the work was in close touch with the workmen and with the actual building operations, many problems being solved at the site of the building and with the co-operation of the workmen. Relationships were more personal and required the close and intimate association of groups of men of similar training and interests.

Since the Renaissance in the 15th century, this status of things has changed, the individual has become of greater importance, and the architect is now quite separate and distinct from the builder, with the consequence that the former has not now the close intimacy with the building and the workmen that he formerly had.

The nineteenth century was primarily an era of scientific, industrial and commercial development, and people generally were busily engaged therewith. Art and architecture were regarded as subjects of only secondary importance. As an offsetting advantage, however, many new and excellent building materials, including particularly steel and Portland cement, were placed on the market. New methods were perfected for the handling and transportation of materials. In conjunction with this advance, the requirements for an up-to-date building, with its steel frame, its mechanical, electrical, sanitary and other equipment, have been immensely increased, so much so, that no one can hope to cover the field, and the results must be secured by the co-operation of specialists.

With these added requirements of the modern building, labor troubles have not been absent, the old apprentice system has broken down, the workman is at liberty to choose any trade he pleases and to change to another if he so pleases. As a consequence, the skill of the average artisan and of the contractor who has learned his business in the same haphazard way, is not great, and as many an owner and architect knows to his sorrow and loss, under our present system of doing ccntract work, the attempt to obtain well and intelligently executed work is many times a trying experience.

We are still familiar with the buildings in our own locality,

and in these days of travel and photography at least to some extent with the buildings elsewhere. We cannot help being struck with their variety, not only in height, but in quality and kind of materials, and last but not least, in their design. We have been and now are going through a transition period about which people in the recent past, if not at this present time, have been very pessimistic, but which, if looked upon in a larger way, this pessimism would not seem altogether justified.

To these persons the architecture of the good old days appears as an ordinary evolution, whereas in modern work they see the use of the forms of past styles without due regard to the reasonableness of such use.

In what follows I will endeavor to show briefly in what way the architecture down to the Renaissance appears as an orderly evolution, and how the architecture since the Renaissance may also be looked upon as an evolution, possibly just as orderly as that which preceded it.

Evolution is a very modern term, one with which our fathers were not familiar when they were young men, but its application to architecture has produced some very interesting results which are not apparent without some study, for, due to a variety of causes, amongst them the involved and rapidly changing conditions in these days, particularly in a new country where we have been more or less detached from other and older nations in which the artistic instincts are or were highly developed and where at times conditions conducive to the best work were very favorable.

Our architectural heritage is the product of and reflects the experience of the human race from the earliest times, but our particular interest lies in the art of western Europe, dating from the days of classic Greece down to the presest time.

Regarded from this standpoint, the work of the competent architect takes on an added dignity and value with which it is not always credited, the architect at times being looked upon as somewhat of a dreamer, neither very practical nor very businesslike.

At this point, for the encouragement of the architectural student and to ensure that our engineering friends do not become too conceited and self-satisfied, I would remind them that they, too, at times, are accused of not being very practical and businesslike, and I am sure that some lawyers, not to mention the doctors and clergy, are not good business men; in fact, all of us as professional men, must be careful to cultivate a true prospective and learn to appreciate that our work is not ordinarily an end in itself but only a means by which some useful purpose is accomplished. When we insist on too much art, too much engineering or too much of the commercial, we are not rendering the most beneficial service.

Let us try, therefore, to be broadminded and so capable as not to let the technical difficulites and the special interests of our professions blind us to the relative merits of the various aspects of the problem before us.

Referring to my special subject, I find that the training of the

ngineer sometimes makes it difficult for him to appreciate that architecture is not strictly, in fact may be almost not at all, a utilitarian art. The engineer's chief aim is efficiency at a moderate cost. On the other hand, the architect is required to design a building which shall not only serve every useful purpose, but shall have at least some merit as a work of art, and this art costs money, how much it does or should cost depending on the nature of the building. Therefore, while I would caution the architect not to allow his love for his art to carry him away, but to carefully endeavor to meet every utilitarian requirement, I would urge the young engineer to try to appreciate the true worth of good architecture and its value as an investment.

Architecture, according to one well known definition, is the art of building, which art calls for the design of buildings in accordance with the underlying scientific principles of good construction with materials so selected and disposed as to form structures at once both useful and beautiful.

The well known writer on architecture, Prof. Chas. H. Moore, says "beauty in architecture may, I think, be almost defined as the artistic co-ordination of structural parts as in any natural form; a well designed building has a consistent internal anatomy and its external character is a consequence and expression of this."

It is very common to speak in a popular way of buildings being designed in the classic, Gothic, or some other style. In a steel frame structure we cannot tell which it is to be until it is time to dress the steel frame up in its exterior covering, and as clothes do not make the man, neither does the dress up of a building constitute a true style.

An architectural style is fundamentally the product of a problem in construction, and it is only the systematic carrying out of a constructive principle that constitutes a style in architecture.

Professor Moore, to whom I have already referred, claims that thus far in Europe there are "but three consistent and distinctive styles;" namely, the Greek, Byzantine, and the Gothic styles, the architecture of the lintel, the dome and the vault. All other so called styles are found in buildings of a transitional character or in buildings composed of mixed elements not in organic fusion.

According to another writer, Professor Hamlin, all architecture is based on one or more of four fundamental structural principles; that of,

1. The lintel of beam
2. The arch of vault
3. The truss (with which we will include riveted steel frame construction)
4. Cohesive construction, (which includes concrete, plain and and reinforced).

The three historic styles already mentioned employ only the principles of the lintel and arch or vault with its modification, the dome,—truss and cohesive construction, were but little used until

very recently when the manufacture of steel and Portland cement has made their use possible in a large way.

Viewing architecture as a problem in the art of building construction, based on some fundamental structural principle and considering the fact that the older nations used but two out of four such fundamental structural principles, the opportunity for people of this day and generation to do something new and original would seem plain.

However, the limitations of the human mind and the conditions under which we live and work are such, that nothing of great value can come hastily, but unless the people of the former times were more capable than we are with our increased facilities both in materials and methods of construction we and those following us must produce buildings better adapted to our needs and new in style in that they employ structural principles practically new, and possessing greater flexibility and a wider application than those in use before the modern era.

Buildings are considered commonly under the two subdivisions of plan and superstructure, the two being intimately associated in the mind of the designer, and both are governed by the necessity of furnishing such floor spaces as may be required, so arranged and disposed with bearing walls and points of support provided and adapted to a natural, simple and straightforward use of the system or systems of construction which are to be employed, the whole building being so disposed as to indicate, so far as may be, the purpose for which it is intended.

Architectural planning may be considered under three heads:

1. City and Town Planning.
2. Group Planning.
3. Planning of single buildings.

Town and city planning, a subject long neglected, is now being given much careful attention, and the civil engineer and the surveyor as well as the architect, in some measure at least, should acquaint himself with the problem.

My observation is that at least some civil engineers and surveyors are not good town planners or planners for the development of suburban properties for which work in times of real estate activity there is much demand.

In city planning it may be best to cut down hills and fill up low places to obtain straight streets and easy grades, but this cannot be done in the outlying suburb or country where to lay down a gridiron plan of roads and streets regardless of hill and dale is little short of a crime.

Prepare a contour map with necessary data for intelligent study and if need be seek the co-operation of a landscape architect.

The planning of single buildings or groups of buildings is one that comes well within the province of the regular architectural practitioner. City planning and landscape architecture are in the nature of specialties, though architects now pay more attention than formerly to the securing of proper artistic settings for their

buildings; in some cases with marked success as in the work of Mr. Charles A. Platt.

In a series of buildings for a large hospital, or in a cluster of college buildings we should find an example of group planning, in which the various building units are so disposed as to size, style in design, and in their relation to each other and to their surroundings as to best serve their purpose of use, and at the same time give the group a unity and maximum of architectural value.

The planning of single buildings is a matter of almost daily occurrence to the average architect, and the completed plan which must be developed to meet with due economy of space the requirements of use should also be so disposed as to make possible a super-

Fig. 1. The Parthenon, Athens

structure at once sound structurally, truthful in the expression of its purpose, and of artistic merit.

The most successful building is the result of such a nice adjustment of all these demands as will most nearly meet all the conditions, for they cannot all be fully complied with.

The study of a house planned and designed by a competent architect will quickly show his skill. The relation of all the rooms, and all the means of communication will seem natural and reasonable, there will be no lost space, the bearing partitions will all rest on proper supports, and no serious difficulty would appear to have been encountered anywhere.

The exterior will be a natural development of the plan, materials

will be so used as to take best advantage of their physical properties, both structurally and for color effect. Altogether the house as a whole with its setting will have a natural, cheerful and refined appearance that will make it a source of pleasure and uplift to the dweller therein and to him who passes by.

In the problems of design the most ancient architecture of which we make practical use at the present time is that of Greece. The classic Greek work at its best period dates from the 4th and 5th centuries before the Christian era. It is of the simple column and lintel or beam type of construction.

The next in order, the work of the Romans, is found at its best in the early days of the Christian era. The Romans combined the use of the arch and the vault with that of the column and the beam.

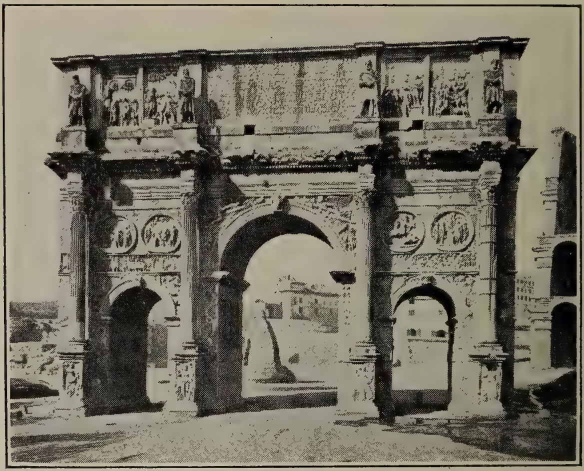


Fig. 2. Arch of Constantine, Rome

Next in chronological order we have the architecture of the dome, brought to its present perfection in Constantinople, originally known as Byzantium, and is found at its best in the sixth century A.D. In Western Europe in the middle ages the dome was little used, but a wonderful system of vault construction was perfected in Northern France. This reached its greatest perfection in the thirteenth century. Various modifications of this style known as Gothic, spread over Western Europe. In Italy, Gothic architecture never had such hold.

The Byzantine and Gothic styles had their origin in the architecture of the Romans.

The Byzantine style has continued to influence the architecture of the Orient but has not greatly influenced the architecture of Western Europe, where by the fifteenth century Gothic art had exhausted itself.

Europe, in the fifteenth century, returned to a study of the civil-

zation, art and literature of classic days. Italy, least under the domination of Gothic influences and surrounded with the ruins of the architecture of the Romans, was first to study and use the Roman fcrms.

Unfortunate, it may be, but the Italians of the Renaissance, unlike their ancient brothers, the Etruscans, were poor constructors, while, on the other hand, as painters and sculptors, but particularly as painters, they were wonderfully successful. As a consequence, much careful study was given to Roman forms of architectural detail and ornament, and but little attention to the underlying structural principles of Roman architecture.

This study of Roman forms and art spread to France and then to England, and it is this influence we find in the colonial architecture of the United States.

Following a decline in interest in Roman work, early in the nineteenth century, the study of Greek art and architecture was taken up with much enthusiasm, and attempts were made to reproduce Greek temples and other similar buildings and adapt them to modern uses.

Fig. 3. Wells' Cathedral

These attempts to use Greek and Roman architectural fmsor designed in accordance with systems of construction not now generally applicable and with little regard for principles of sound and straightforward construction, could not attain genuine success.

Having failed with Greek and Roman models, a return was made to a study of Gothic architecture, discarded at the Renaissance, but now claimed as the native and natural style to use.

In England the old Gothic architecture was studied and reproduced in buildings, secular as well as religious, but as with the others the underlying structural principles were no longer applicable, the spirit of the times had changed, and the movement was largely a failure except for church work with which it had always been closely associated.

Thus was brought to a close the early study of and attempts to apply the forms of historic architecture in what have been called the initiative or false styles of modern times.

Following the early study of historic architecture, the architectural profession undertook a careful study of the technique of their art. Every architectural student in the United States who could, joined his French confrere in the Ecole de Beaux arts in Paris, where he learned the art and science of good planning and its relation to the superstructure and the requirements and qualities of good design, and while so doing become a wonderfully proficient and skilful draftsman.

And where do we now find ourselves? Our data regarding the architecture of the past has been carefully worked up and classified, a great variety of excellent building materials are at our disposal, including structural steel and Portland cement, which makes possible two systems of construction, practically not available but a few years ago. Architectural design and draftsmanship have been studied under the greatest modern masters of the art, and schools have been established throughout America to pass the news along.

Fig. 4. Notre Dame, Paris

It is true the best and most successful architects of the present day still use ornamental forms of the great historic styles, but the motto of the successful man is "first things first." Our architects have been so busy doing the big and important things that little leisure have they had; when this leisure time arrives it will be time enough to take up this subject. In the meantime we, both architect and layman, are becoming familiar with the best forms that now exist.

It is true also that our labor conditions are not ideal, our workmen generally are not very contented and few are skilled in their art or trade, but the spirit of the times is becoming one of mutual regard and co-operation, and we may look forward with confidence to a happy solution of this problem also.

Our special course of study of the architecture of the past and

of materials and methods is almost completed, and we will shortly be graduated. Our course of study has been a long one, extending over a period of some four hundred years.

How do these conditions concern each one of us who is interested in the art of building in any direct way?

The modern architect responsible for large work, like the modern engineer charged with the direction of large engineering enterprises, is, to a great extent, an executive, the present day building, if of any dimensions, is a complicated structure, the result of nice adjustment of the varying requirements, and each branch of the work must be well designed and well executed.

No man is competent to design and supervise the construction

Fig. 5. Packard Commercial School,
H. F. Ballantyne, Architect

and installation of all these works. We must engage specialists, experts in foundation and steel frame construction, mechanical and electrical engineers, sanitary and other experts, and it may be sculptors, modellers and decorators, together with manyartisans, specialists in as many as 25 or 30 different trades.

This is a formidable array of expert talent for the architect to deal with and hold his own, so Mr. Engineer, when some special department of the work does not seem quite ideal, please do not assume a too critical or fault-finding attude, but show a spirit of

friendly co-operation in an endeavor to bring about the best results. It may be that some other limitation cramps your work; it may be that something has been overlooked. In any case the wide awake architect will be glad of your co-operation if behind it is the true spirit of mutual helpfulness.

When the problem in hand is mainly an engineering one but involving some architectural work, the architect will work with the engineer, and when the problem is mainly an architectural one the engineer will work with the architect; in either case we will each put forth our best effort to give our employer a good serviceable and creditable piece of work.

The outlook for architecture in America, including both Canada and the United States, appears very bright. The country is very rich and should be prosperous. Nature has provided us generously with building materials. We have talent drawn from all the countries of Europe, but we are not held down by the limitations and restrictions of ancient custom, and are at liberty to choose the best wherever we may find it. I therefore believe there is the opportunity before us of making the architecture of America the greatest of the modern world.

THE CORROSION OF IRON AND STEEL AND ITS PREVENTION

H. C. Quail, B.A.Sc.

(Concluded from November Issue)

There were two strong commercial incentives towards the attaining of this result. In the first place the electrolytic theory of corrosion had been promulgated a few years before, and, as evidence accumulated, it pointed more and more directly towards the probable soundness of that hypothesis: therefore, since this theory indicated the almost certain resistance to corrosion of a pure and homogenous metal,—that is to say, of a ferrite of uniform density,—it was evident that the commercial possibilities of such a material were very great.

In the second place, there was the spur found in the growing demand for a pure iron for use in the construction of the cores of electrical machinery:—i. e., a metal that had high magnetic permeability, and which would not take on a permenant magnetization.

At the conclusion of the effort a general specification was issued for this "Ingot Iron," as it is called, and the mill is held rigidly to it, to the effect that the total impurities shall not exceed 0.06 per cent. This, it must be noted, is a point very much below that required for manganese alone two years previously; and concerning which it was declared that the metal so produced would be the best non-corrosive metal in existence.

That this specification is met and lived up to at the furnaces is shown by reference to the records of the heats. An analysis is' of course, made of each heat and a record of it is kept. That record

was turned over without reservation, for the investigation upon the results of which this article is based; and heat after heat would run from 0.055 per cent. to 0.058 per cent of total impurities. Two analyses taken at random, are given as representative of hundreds in the record. They are:—

	I	II
Sulphur	0.025%	0.023%
Phosphorus	0.004%	0.004%
Carbon	0.01%	0.01%
Manganese	0.01%	0.02%
Total impurities	0.049%	0.057%
Purity of metal	99.951%	99.943%

Unfortunately, the nearer a commercial iron or steel approaches purity, the more difficult it is to produce it in a thoroughly degasified condition; for, under such conditions, the iron is particularly sensitive to oxygen and absorbs this, probably the most injurious of all elements, more readily than would a less pure steel made by the same process. It has been found in the manipulation of the metal and the rolling into sheets, into which form the whole output of the mill goes, that the included oxygen has a very important influence on the behaviour of metal in the rolls and upon the character of the finished product. For that reason, oxygen determinations are made of every heat and every possible effort is made to keep it down. The maximum permissible is 0.04 per cent.

In order to demonstrate the properties of this metal, ingot iron, I might quote G. L. Fowler, associate editor of the Railway Gazette, in the issue of September 30, 1910:—"American Ingot Iron,—Its Development and Production."

"Now, having produced a metal of 99.94 per cent. purity, what of its physical properties? It is soft, ductile, and easily worked and welded if treated in the proper manner. In working, the metal acts something like steel. Its hardness by Brinnell test is 520 annealed, and 480 unannealed. The general physical properties of a test specimen eight inches long are:—

Limit of elasticity	41,260 pds. to 46,700 pds.
Ultimate strength	49,770 pds. to 53,950 pds.
Elongation	33%
Reduction of area	57.3% to 68.3%

For the purpose of comparison, two tests of wrought iron are given, as follows:—

Iron	Swedish Charcoal	English Wrought
Limit of elasticity	27,104 pds.	28,000 pds.
Ultimate strength	50,916 pds.	49,600 pds.
Elongation	16.7%	17.2%
Reduction of area	56%	59%

From the above comparisons, it will appear that the purification of the metal has been of great benefit in adding to its physical properties by an increase of strength, the raising of its limit of elasticity,

and by about doubling its ductility as represented by the percentage of elongation and the reduction of area.

Now, what were the conclusions reached regarding the final quality,—resistance to corrosion,—which was the purpose of the investigation?

I might here restate briefly the electrolytic theory of corrosion, thus:—Where two substances of different polarity are immersed in a suitable electrolyte, an electric current is set up, and the substance from which the current flows tends to dissolve. This would indicate that rusting depends on the presence of impurities in the metal or a variation in the homogenity of its structure for the development of this electric current. Under ordinary conditions, water is the electrolyte, and forms the necessary connection between the impurities and the pure metal. The current thus set up is active in the liberation of hydrogen due to the solution of the metal. Oxygen, also, seems to be necessary, and in the electrolytic theory, it seems to remove the layer of gaseous hydrogen which may accumulate on the surface of the iron, and also combines with the metal in solution, forming the oxide of iron, or rust.

It is not claimed for ingot iron that it is absolutely non-corrodible, but that it is very much less so than any other metal of which iron is the base. It has been extensivley used for corrugated culverts; but, as to what the actual life will be, it is impossible to make any definite statement, since none of these culverts have been in use for a sufficient length of time to give any indication as to when the ultimate failure will occur.

The best approach as to what is likely to happen is shown by a laboratory test, using sheets of ingot iron, charcoal iron, and steel. Each plate measured one inch, by two inches, by one-sixteenth of an inch; and they were submerged for three hours in a bath consisting of a twenty-five per cent. solution of sulphuric acid. The loss of the ingot iron was 2.12 per cent.; of the charcoal iron, 59.2 per cent.; and of the steel, 85.5 per cent. The conclusion is obvious, and again, is favorable to the ingot iron.

It is a common statement in text-books, that pure iron is not a commercial product, and this is true in the sense that a perfectly pure iron has not been put on the market; but this ingot iron approaches the condition of ideal purity so closely, and the physical characteristics are so nearly identical with what would be expected from a pure iron that it may be considered as such from a commercial standpoint: moreover, aside from the scientific interest that it possesses, as demonstrative of the electrolytic theory of corrosion and its probable truth, it does possess the great practical values of high resistance to corrosion, good electrical conductivity, and low magnetic retentivity.

After having discussed the prevention of corrosion from the side of the composition of the metal itself and its natural tendency towards oxidation, we may now consider it as attempted by the use of the external coverings.

Given an iron or a steel surface free from moisture,—and that

is a condition that does not always obtain in practice,—that surface may be protected against corrosion so long as there adheres to it a suitably prepared coating which is free from and impervious to moisture. To insure such protection, several methods have been suggested: Barf mentions a coating of mill-scale, but, apart from its cost, it is objectionable owing to the readiness with which the oxide cracks and flakes off when the metal is hammered or bent; thus, the iron is exposed, and, as iron is electro-positive to the oxide, active corrosion and pitting of the exposed metal are promoted. Again, many processes of tinning and galvanizing are employed for pipes, etc., but these methods cannot be adapted to structural purposes, since each member of the structure would have to be treated separately before erection, and could not readily be given additional coatings afterwards. For structural purposes, therefore, the most widely adopted and convenient method of protection is by painting.

Paints for iron and steel work may be divided into two classes: first varnishes,—containing no pigment, generally solution of bitumen, coal tar, pitch, stearine pitch, or wool pitch in tar oils: second, true paints,—composed of finely ground pigment suspended in a vehicle, whose chief constituent is generally linseed oil. The number of such varnishes and paints upon the market to-day is legion; but as a discussion of their relative values belongs rather to the commercial than the scientific aspect of the subject, it is unnecessary for me to make any comments upon their individual merits. I shall confine myself, therefore, merely to some consideration of the general characteristics of the product which is to produce the best results.

In respect to the vehicle, I might say that the effect of oil or fat spread over an iron surface is known to be such that corrosion is inhibited, at least while the oil remains and the iron is idle. Water vapor will not penetrate the oil, but liquid moisture is liable to do so. Many thousands of tons of drying oils are annually applied in the form of paints to steel structures. It is very important that we should know the precise effects of the various oils in use, in order to discover which grade or type will be best under special circumstances.

In the first place, are they capable of dissolving iron to any appreciable extent? If they are, the coats of paint are liable to become saturated solutions of iron or of iron compounds, and, upon exposure to moisture, will absorb water and oxygen, so forming rust. Owing to the great change in volume which this brings about, the paint film may suffer partial disintegration. At best, it will be made porous and serve as but a poor protection for the metal underneath. Other things being equal, therefore, the best drying oil for the manufacture of paint destined to be employed in the covering of iron work, will be the one which exerts the least solvent action upon the iron.

Although such might not be absolutely true under conditions prevalent in practice, nevertheless, it may be said that from the

results obtained in laboratory experiments carried on by Marcy and Friend, the solvent action of the common drying oils,—raw linseed oil, boiled linseed oil, poppy oil and tung oil,—may be neglected. Similar results have been obtained by Tucker in the use of hydrocarbon oils, such as valveline, cylinder oil, and lubricating oil.

Of equal importance with the quality and constituents of the protective coating to be applied, is the condition of the structure to be painted. Too much care cannot be exercised in the preparation of the iron for the priming coat. I am considering here new iron work, and not iron which has already been painted. The sooner the iron receives the priming coat, the better will be the results ever after. This immediate application is, perhaps, the reason stencil marks upon girders, and so on, are cited as testimony to the value of white lead for a priming coat. These marks are put on while the girder is new, even hot, and quite dry; and, they can still be found underneath the subsequently applied paint. The iron to receive the priming coat should be perfectly dry and free from every trace of rust, of dirt, and of grease of any kind. Some engineers would allow the iron to rust in order to remove mill scale; but, it is safer to remove the mill scale by sand-blasting or the use of wire-brushes, rather than run the risk incurred by permitting rusting to begin: for rusting involves pitting, and, unless the rust is scraped out of the pits down to the bare metal,—a difficult and expensive process, rusting will continue beneath the paint.

There are many shops under the management of well-known firms whose reputations should guarantee good work where the superintendents either through ignorance do not realize the importance of proper preparation for painting, or are too much interested in the present financial welfare of their employers to enforce the necessary cleaning before the application of the protective coating. Cases are known where attempts have been made to paint iron that was so corroded that the rust came off on the brush instead of the paint adhering to the metal. Under such shop methods, how can we expect good results?

In addition to being freed from all foreign matter, such as greasy dirt, rust, and mill scale, if satisfactory results are to be expected, the surface must be brought to uniform bearing. All minute holes, cracks, and fissures or apertures between plates and bolts should be filled with a suitable "filling" or "stopping" before the painting is commenced. It is just such openings and inequalities in the surface that form nuclei for corrosion, because of the opportunity they offer for the gathering of moisture. The condition of "metal to metal" is particularly objectionable, as local galvanic action is thereby excited, and that inevitably induces corrosion. A protective paint film, in order to be efficient, must be continuous over the whole surface; and that result cannot be secured unless that surface is made perfectly solid and continuous in the first place.

In the above connection, I may quote a section from the current Standard Paint Specifications of the Canadian Pacific Railway:—"Fineness of pigment and covering power will receive special atten-

tion, and comparison of fineness shall be made in the following manner. The paint, having been first brought to a temperature of about 70 deg. F. and then thoroughly stirred up, a single drop will be allowed to fall upon a horizontal clean sheet of glass. The glass will then be placed in a vertical position for one hour, at the end of which time, no separation of pigment from vehicle should be noticeable. If the paint be too thick for a drop to run down the glass a distance of three inches in one hour, it shall be thinned with linseed oil to the necessary consistency for testing."

This, of course, means a fairly thick paint, and requires a liberal amount of energy in its application; for it must be well spread with a good brush; not merely daubed on, but worked into the corners and crevices, and not too thickly. The best workmen should be employed in putting on this priming coat; they should work under rigid inspection, and from three to four days should be allowed for the paint to dry thoroughly.

Again, quoting from the specifications previously mentioned. "Drying:—Paint will not be accepted, the ordinary coating of which, when spread on glass, dries dust-proof in less than ten hours or in more than fourteen hours, when kept at 70 deg. F."

"Consistency.—The paint should be of proper consistency, not too heavy to be brushed out without additional thinning, not thin enough to cause it to run, and must cover wood or iron surfaces thoroughly with two coats."

When we turn from the consideration of the priming coat to that of the final coat, we find that the conditions that must be fulfilled for the one are obligatory for the success of the other. The final coats, however, vary greatly both in vehicle and in pigment. As a sample, I will again refer to the Canadian Pacific Railway Standard Paint Specifications No. 5.

Bridge Paint

Pigment: Graphite, natural or artificial, containing not less than seventy-five per cent. graphite carbon, entirely free from super-added pigment or adulterant, 100%.

Vehicle: Boiled linseed oil of best quality, thoroughly settled, 90.95%; turpentine dryer, best quality, 5% to 10%; spirits of turpentine, 3% to 8%.

Linseed oil does not "dry" in the sense of the evaporation of water, but rather by the absorption of oxygen, which converts the fluid oil into a solid, elastic skin of oxidized oil. On that account, it is considered advisable not to add any volatile spirit in large quantities, such as turpentine, since it is thought to impoverish the skin when it evaporates.

The rate and nature of the drying of the paint film are very important, and will depend largely on the skill with which the ingredients of the paint have been amalgamated in view of local conditions. Drying should proceed uniformly throughout the whole depth of the film; otherwise the skin will form on top of the film which will impede and may entirely prevent the drying of the paint beneath. Again, the drying should be so regulated that it proceeds

neither too quickly nor too slowly. If it proceed too slowly, the paint is unduly exposed to atmospheric conditions before it is in a condition to resist them: if, on the other hand, the drying is too rapid, a state of strain will be induced in the film. Severe chemical reaction may also be set up that will probably result in rapid deterioration.

In conclusion, the fact must be emphasized that the great object to aim at in the final or "weather" film of a protective paint is to render it as impervious as possible to moisture. It has been conclusively proved that protective paints will only effect their purpose in strict relation to the degree of permeability to moisture which they possess. It is for that reason that many modern experts prefer the final protective film to consist largely of pigment; their view is that thus greater impermeability to moisture is secured. This opinion has much to commend it, provided always that the physical condition of the pigment is suitable. It would, for example, be useless to load the final protective film with badly ground or irregularly shaped particles of pigment. Hence, the practical rule that the greatest protective value is obtained from paints that, in their finishing coats, partake of the nature of a highly finished enamel.

It has been found through actual practice that, in cases where the steel comes in contact with the smoke, exhaust steam, cinders, and gases from a locomotive, paint will not protect the steel for any length of time, although under ordinary circumstances, the paint might have been sufficient covering for several years. Parts of a bridge have been totally destroyed when subject under strong pressure to the mechanical action of the discharge and the chemical action of the gases contained therein; while the upper members of the same structure which did not come in contact with these were practically unaffected. The most satisfactory protection in such cases is a casing of concrete, that is, for the unprotected stringers, floor beams and lower chords. Some non-corrosive material, such as wood, asbestos-board, etc., may be interposed between the floor system and the track to protect the upper members when the road passes beneath the structure.

The protective qualities of cement grout are well illustrate by the results of the investigations carried out during the removal of the Gillender Building, New York city. This was a seventeen storey, steel-frame office building, which had been in use for fourteen years and was being removed to make room for a larger and more modern structure. With regard to it, I might quote T. K. Thomson, "It would seem that if the columns had been encased and filled with wet concrete, there would have been no danger of rust, and they could thus have been easily protected from electrolysis. Oil or oil paints should be placed on steel to be thus encased." As a matter of fact, where the columns had been encased in mortar the oil had been destroyed, but not the pigment. Where the grout had not been in proper contact the column appeared as though it had been exposed to weathering for several years. Notwithstanding all that had been said in proof of concrete being a preservative of steel,

therefore, it is quite evident that it is so only when proper precautions are taken in applying the protective envelope.

Our considerations so far have dealt with iron or steel subject directly to the influence of atmospheric conditions: but there is another phase of the question into which the matter of reinforced concrete enters. In 1909, the Concrete Institute of Great Britain through its science standing committee, sent out a circular asking for the results of experience on the question whether rusting of steel takes place when the metal is covered by concrete. As a result of observations given in reply, the committee drew up the following conclusions:—

Reinforced will last as long as plain concrete in any situation provided that special precautions be taken during construction. The materials,—cement, sand and stone,—must be of good quality; they must be thoroughly mixed, and scientifically proportioned so as to be practically waterproof and air-proof. The mixture must be fairly wet, and must be well punned into position, so as to minimize voids. The aggregate should be as non-porous as possible, and any aggregate which is known to have a chemical action on steel should be avoided. The concrete covering should be in no case less than one-half an inch in thickness. In the case of structures exposed to very severe conditions, the concrete covering should be increased fifty per cent., and the dimension of the aggregate lowered in order that a denser skin may be formed. Some "waterproof" coating may be used on the surface in order to make certain the exclusion of all moisture. "It (the reinforcing) should not be oiled or painted, and thick rust should be scraped and brushed off the metal before placing." "When rust has been noted (on iron in concrete) the protecting envelope has either been fissured, or else not in close contact everywhere with the metal."

There are well authenticated cases of steel being removed from concrete after from fifteen to twenty years in just as good condition as it was the day it was imbedded. We have, moreover, the knowledge that scores of reinforced concrete structures, built ten, fifteen, or twenty years ago, are still standing and doing their work with no indication of weakness or disruption because of rusting steel. With that evidence at hand on every side, the fear that our works of reinforced concrete are slowly being destroyed by the rusting of the steel element seems rather unfounded.

Results tending to confirm these statements with reference to reinforcements both in stone and cinder concrete were reached by Professor Charles L. Norton, of Boston, Mass., and Mr. Breuillie of France through laboratory tests. These investigations are particularly noteworthy because of the general belief that cinder concrete, owing to the presence of the sulphur in the cinders, would tend rather to stimulate corrosion. Their conclusions emphasized the point made by Professor Spencer B. Newberry, as follows:—

". . . . The amount of this sulphur is, however, extremely small. . . . The cinders proved to contain only 0.61 per cent. sulphur. This amount is quite insignificant, and even if all oxidized

to sulphuric acid, it would at once be taken up and neutralized in concrete by the cement present, and would by no possibility attack the iron."

Practical experience and scientific investigation, therefore, would appear to warrant the decision that steel or iron reinforcement may be embedded in either cinder or stone concrete provided that a close contact between the concrete and the steel at all points be secured, and that no cracks develop in the concrete to expose the metal to attack.

Because the difficulty met with in the corrosion of iron and steel is familiar, and one for which engineers have always had to find some remedy, adequate or inadequate,—in every case temporary.—there is a tendency to think that it is understood: but the more searching the examination to which the process is submitted, the more certain it is that our knowledge is still exceedingly incomplete. In some matters, we may accept mere results without grave risk; but the economic importance attaching to the oxidation of iron has demanded the most searching inquiry into causes with a view to discovering preventive measures. The greater extent of use, the increasing severity of the exposure of iron structures, probably also the greater non-uniformity of the metal composing them, all have augmented the evil of rusting. As yet the most widely used method of protecting wholly exposed metal is by painting, and the inadequacy of that method, even under the most careful manipulation, has been made clear. Improvement seems possible in two directions only,—perfecting the technic of paint in order to secure a coating of greater strength, solidity, and longer life: and using a less perishable metal beneath it, so as to be less dependent on the protecting power of the paint. The former resource has been explored and there is no prospect of immediate improvement in that direction. The great field of painted steel, therefore, is probably the most important for the application of a rust-resistant iron; and that is now offered us in the shape of ingot iron. Paint for iron will always be necessary, but a purer iron will certainly require less attention and relieve paint and the paint industry of a great share of the excessive responsibility that has been forced upon them. The production of low impurity ingot iron,—equivalent to a pure wrought iron, but produced by the large scale process of the steel furnace, must, therefore, be ranked as one of the most important innovations in the metallurgy of iron, since above all its importance lies in its promise to cut down the world's prodigious rate of rust loss to a fraction of its present amount.

T. V. McCarthy, B.A., Sc., '11, is assistant engineer on the Pitometer Survey work in the waterworks department, City Hall, Toronto.

S. E. Flook, B.A., Sc., '11, has a practice as Ontario Land surveyor and civil engineer at Port Arthur, Ont. His address is 43 Cumberland St.

ELECTRIC SMELTING OF IRON ORE IN CANADA

T. R. Loudon, B.A. Sc.*

It is a well known fact that Canadian iron ores are not well suited for smelting in the ordinary blast furnace. For the most part these ores are magnetic and contain high percentages of undesirable elements such as titanium, phosphorus, sulphur, or are very siliceous. Magnetic separation has been tried in order to rid the ores of the greater proportion of the undesirable "gangue" and experiments along these lines are still in progress; but, so far, although technically successful results have been obtained, no very marked commercial success has been made. In many cases, even where separation had been used, it was still necessary to either briquet or nodulize the fine particels of ore, which without this treatment, would simply be carried out of the furnace by the blast.

Since the introduction of the electric furnace into the steel industry, it has been well recognized that these Canadian ores could be smelted by electro-thermic means. In fact, in 1906, the Dominion Government issued the results of extensive investigations on the electric furnace iron and steel industry of Europe. This investigation was followed by a series of experiments at Sault Ste. Marie with a view to utilizing Canadian magnetite ores. The furnace used in these experiments was simply an enlarged pot into which dipped a vertical carbon electrode, the other terminal being made by the hearth of the furnace which was built of a carbonaceous material as shown in Fig. 1. The charge was placed around the vertical electrode and reduction took place mainly at the lower part of the furnace, the gases resulting from the reactions escaping freely from the top. Although these experiments were technically satisfactory, yet it was seen that great improvements would have to be made in order to operate on a commercial scale. For instance, the escape of the gases from the top of the furnace represented a great heat loss. The charge also had a tendency to clog. In fact, the vertical electrode passing through the charge was seen to be impossible.

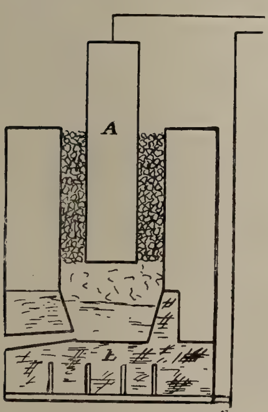


Fig. 1

Since the publishing of the results of these investigations, nothing has resulted commercially in Canada; but as a direct result of the experiments mentioned above, a commercially successful process for the smelting of iron has been evolved in Sweden. This furnace, a cut of which is shown in Fig. 2, is nothing more nor less than a structure similar in outline to the upper part of an ordinary blast furnace, this portion being superimposed upon a crucible into which the electrodes project. This furnace was running successfully in 1911, and since then the field of operations has been very much extended. Interesting as these results were, nothing further has been done in Canada.

* James Loudon & Hertzberg, Consulting Engineers.

There are, of course, many economic reasons why the electric furnace has not been more enthusiastically received in Canada in

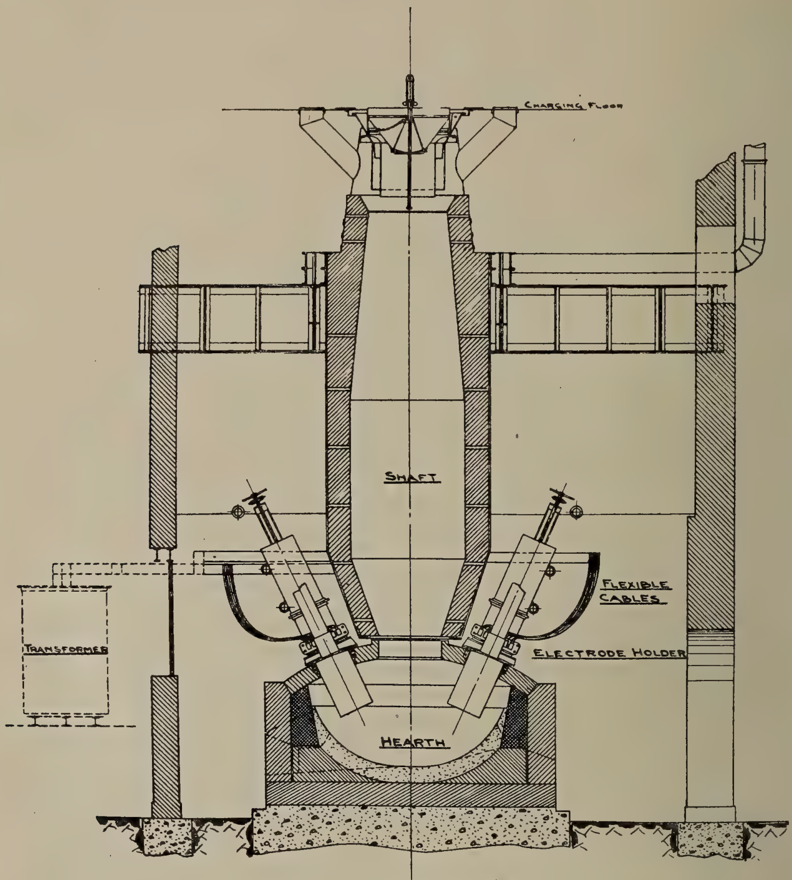


Fig. 2

the steel industry, but the fact that the processes require operators of experience has, perhaps, been the greatest reason why nothing has been done of any account. Those having the necessary experience are few and far between. Much investigation, however, has been independently carried on, and the new plant of the Moffat-Irving Steel Co., Toronto, is the result of such research.

The furnace used in this plant is diagramatically shown in Fig. 3. Fig. 4 is a photograph of the original crucible, Fig. 5 being a view of the final furnace which, it will be seen, differs merely in detail from the original construction.

As indicated in Fig. 3, the ore particles are fed into the upper stack by mechanical means. The requisite limestone is also fed in at the same level. The carbon, in the form of

finely ground coke, is fed into the crucible at the lower level indicated. In falling, the ore particles come in contact with a strongly reducing hot atmosphere of carbon monoxide gas and partial reduction is brought about, the final rections taking place in the crucible of the furnace. The limestone in falling, is burnt to lime by the time it has reached the crucible. This, of course, means the addition of carbon dioxide to the gases and in consequence makes the reducing efficiency of the gases less, but the result has not been found to interfere seriously with the process.

It can be readily seen that fine Canadian magnetites are especially adopted for use in this form of

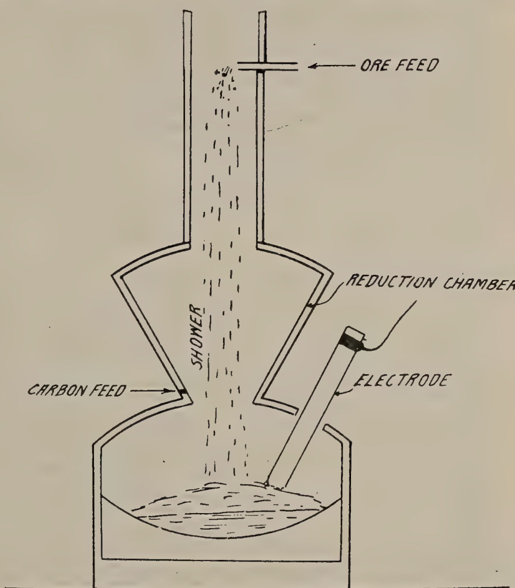


Fig 3

Fig. 4

Fig. 5

furnace. It has been found that in many cases it is not necessary to even concentrate these ores as the very basic slag that can be used in the electric furnace makes the handling of phosphorus and sulphur very easy.

This particular furnace is 300 k.w. capacity and is operated on three phase current. Merely one electrode is shown in the cut, but actually there are three, situated at equal intervals around the

furnace and dipping into the crucible at about 60° to the horizontal. The transformer is built to give a range of voltage from 56 to 84 volts, as required. Hand regulation of the position of the electrodes is used, there being no difficulty experienced in this respect as very even running conditions are obtained. The electrodes are 5⅛ inch graphite and pass through water coolers in the roof.

As would be expected, the metal resulting from this furnace is very sound, this, of course, being a characteristic common to all electric furnace steel. In connection with the work on the furnace, the writer has made a series of tests of the steel with the following results:—

		Natural Specimen			Heat Refined		
Heat	Carbon	Elastic limit	Ultimate strength	Per cent. Elonga'n in 2 ins.	Elastic limit	Ultimate strength	Per cent. Elonga'n in 2 ins.
167	.23	53,300	68,950	12.5	52,300	72,100	26.25
167	.18	47,500	63,900	15	46,300	66,850	25
171	.31	56,000	82,800	12.5	53,000	84,500	22.5
175	.12	49,200	53,700	17.5	47,050	57,450	35
178	.23	52,500	68,750	13.75	53,600	70,500	27.5
181	.35	53,300	84,600	10	53,950	88,400	20
184	.21	59,450	80,050	15	59,200	81,500	22.5
187	.29	49,950	74,850	15	50,500	76,650	30

The effect of heat refining is very marked, as indicated by the gain in ductility.

It is of great interest to note that the steel obtained is very fluid, which, of course, when used for steel castings, gave very clean surfaces such as are ordinarily only obtained in grey iron castings. In fact, it was difficult to convince some users that such was not the case without actually breaking the casting and noting the ductility and fracture.

R. L. Greene, '10, of 23 Sparks St., Ottawa, is agent for the Canadian Allis-Chalmers Limited, founders and engineers.

H. G. Hall, B.A., Sc., '11, is assistant superintendent of the Woodstock water and light system, Woodstock, Ont.

M. V. Sauer, B.A., Sc., '01, formerly with the Ontario Power Co., is now with the Greater Winnipeg Water District, Winnipeg, Ont.

W. L. McFaul, B.A.Sc., '13, is employed as inspector on the city engineer's staff at Port Arthur, Ont.

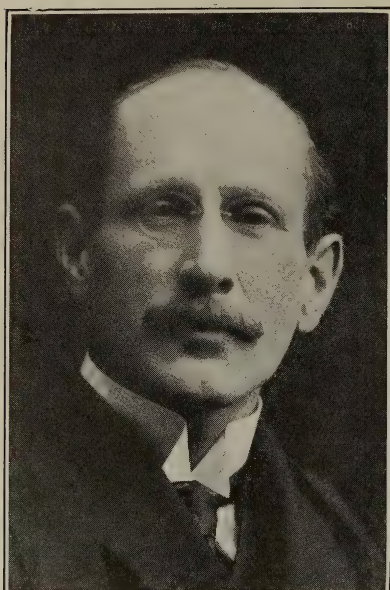
E. P. A. Phillips, B.A.Sc., '05, until recently city engineer of Port Arthur, Ont., is now a member of the firm Phillips & Benner, Ontario land surveyors, Ruttan Block, Port Arthur.

J. B. Temple, B.A.Sc., '11, is structural engineer for the Toronto Iron Works, Toronto.

BIOGRAPHY

PROF. J. W. BAIN, B.A., Sc., '96

J. W. Bain, B.A., Sc., '96, associate professor of applied chemistry in the faculty of applied science and engineering, of the University of Toronto, was born of Scotch parentage in London, England. At six years of age he came to Canada and received his early education in the public schools of Toronto and in Jarvis and Harbord Collegiate Institutes. He entered the School of Practical Science in 1893 and graduated in mining in 1897. During the following two years he had a fellowship in mining at the "School," and from 1899 to 1903 he was demonstrator in assaying. He was appointed lecturer in applied chemistry in 1903 and was made associate professor in 1907, which position he has so ably filled up to the present time.



Prof. J. W Bain, '96

During this period Professor Bain's time has not by any means been entirely devoted to academic work alone. In the summer of 1896 he was engaged in the Regina Gold Mill at Lake of the Woods, and during the following summer he was in charge of the custom work carried on at the "School" where the milling plant was first installed in the Engineering Building. During the summers of 1898, 1902, 1904, and 1906 he was engaged in carrying on summer mining schools in association with the director of the School of Mines, Kingston, for the Ontario Bureau of Mines. This work consisted largely of giving courses of lectures and laboratory instruction to prospectors, etc., at various points throughout the province.

In 1899 he was employed to collect minerals for the Paris Exposition of 1900 by the Ontario Bureau of Mines, of which he was secretary for the following year. In 1901 he took post-graduate work in chemistry at "Polytecknikum" in Zurich, Switzerland. From 1903 to 1908 his summers were spent in research and professional work of an extensive nature in chemistry. Since 1909 he has been engaged in active professional work in chemical engineering and research work in connection with a manufacturing company in United States. He has been employed as an expert by a large number of corporations and individuals, including the city of Toronto, the Consumers' Gompany, Mackenzie, Mann & Company, etc.

Professor Bain is a member of the American Institute of Chemical

Engineers. He is vice-chairman of the Canadian Section of the Society of Chemical Industry for 1913, and was treasurer of the same society during the ten previous years.

Professor Bain is one of those men whose unassuming manner and quiet modesty regarding his own capabilities, naturally resent publicity, but whose qualifications in his chosen profession have won for him a very enviable position in the chemical engineering world. Furthermore, his sterling qualities of character, and the excellent work which he has done at the "School," always instructing engineering students from an engineering viewpoint, have won for him an enviable place in the minds and hearts of "School" men. He has their best wishes for continued and increased success in his work and we trust that he may long be a chief factor in moulding men to go out into the engineering world, fitted to cope with problems related to the engineering profession.

THE SANITARY AND HIGHWAY CLUB

Last year the fourth year men taking the Sanitary and Highway option in the civil engineering course, organized a club known as The Sanitary and Highway Club. The purpose of the club is to benefit the members by arranging excursions to various places of interest so that they may become acquainted with the practical phases of the work in which they are interested. It has already become one of the most progressive and beneficial organizations in the university. The officers elected for the present year are as follows:—Hon. president, P. Gillespie, B.A.Sc.; hon. vice-president, A. T. Laing, B.A.Sc.; president, J. A. P. Marshall; vice-president, E. L. Bedard; secretary-treasurer, J. J. Campbell.

On October 25th, the club visited the Toronto sewage disposal works on Morley avenue under the direction of Professor Gillespie. Mr. J. H. Nevitt, '03, who is the engineer in charge, took the men through the entire works and elucidated the different functions of the machinery and the various departments of the plant. On November 3rd, through the courtesy of Mr. R. W. Worthington, '05, the pumping sewer station at Sunnyside, which serves the western part of the city, was inspected and the layout carefully explained by Professor Gillespie. On the afternoon of the same day Mr. Laing took the members for a tour over some of the York county roads, including a Rocmac road under construction, the Dolarway type on the Lake Shore road and also the roads through the Home Smith property adjoining the Humber. On their return they inspected the large trunk sewer under construction on Bloor street west.

On the evening of November 15th, after a visit to the North Toronto sewage disposal plant at Leaside, an informal dinner was held at the Tea Pot Inn. Professor Gillespie gave an instructive talk on the sewage disposal works at Birmingham, England, and Mr. Laing spoke briefly on the roads of Southern Europe. Both of these speakers, having spent the summer on the continent, gave the members some valuable and interesting information. The

remainder of the evening was spent viewing the exhibits at the Electric Show in the Arena.

On November 28th, accompanied by Professor Gillespie and Dr. Amyot, the members of the club journeyed to Berlin, where they were met by the city engineer, H. Johnston, '03, and assistant city engineer, M. Pequenat, '08. On arriving at the sewer farm, the history and developments which led to the adoption of sand filtration were related by Dr. Amyot. The methods of operation and details of construction were thoroughly explained by Messrs. Johnston and Pequenat. The plant, which has been a model of efficiency since its inception, was one of three of its kind on the continent at the time of its construction. The members of the party were the guests of Mr. and Mrs. Pequenat during the evening.

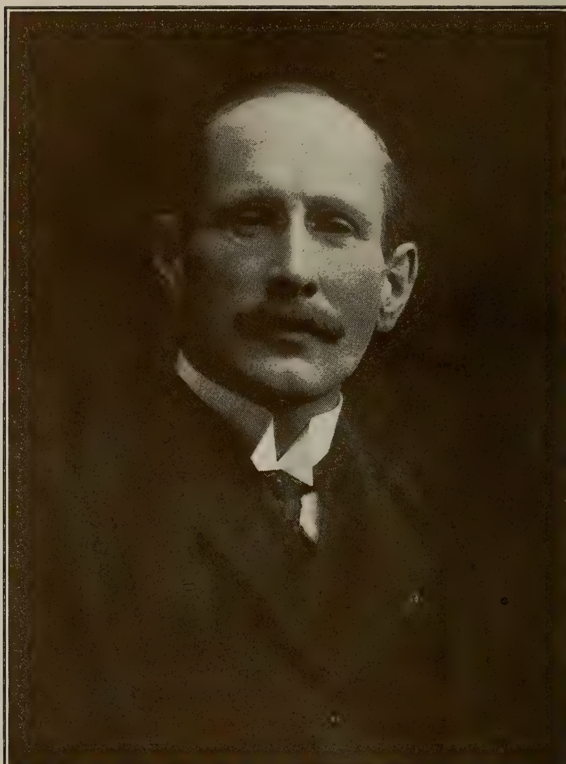
On the following day the waterworks and the sewage disposal plant at Preston were inspected. Preston has an ideal water supply system for a town, the water being collected by gravity from springs and pumped to a stand pipe, from which it is distributed to all parts of the town. On the following day the party invaded Stratford, where the pumping machinery and sprinkling filters at the sewage disposal plants were particularly interesting.

On December 12th they visited the Woodbine sewage plant, where the inadequacy of the contact beds for performing their work has led the city to pump the sewage to the main plant on Morley avenue.

On December 13th, under the direction of Prof. Ardagh, they paid a visit to the Provincial Board of Health Experimental Station on Niagara St. Here the staff was found to consist entirely of "School" graduates, including Messrs. Delaporte, C. Avery, and C. S. Robertson. Other places of interest visited during the fall term were: (1)The Weston sewage plant, which is under construction; (2) The city's slow sand filtration plant at the Island; (3) The plant of the Warren Paving Co.; (4) The city's asphalt paving plant, of which Mr. F. G. Marriott, '03, is in charge; (5) The John street pumping station where the city is installing two fifteen million gallon electrically driven turbines to replace the two old reciprocating pumps now in use.

The course in sanitary and highway engineering has been enlarged during the last year. The new apparatus acquired by the highway laboratory has afforded better and more varied tests on road materials. The course in sanitation under Dr. Amyot has been extended by including laboratory work in sanitary bacteriology under Dr. Fitzgerald. The new course of lectures by C. R. Young on miscellaneous structures, including water towers, standpipes and highway culverts is a valuable addition to the course.

A series of informal dinners is being held, at which the men discuss various phases of the work in which they are interested. All those who so unselfishly assisted in making the excursions a success are the recipients of the heartiest thanks of the members of the club.



PROF. J. W. BAIN

Supplement to "Applied Science," February, 1914

APPLIED SCIENCE

INCORPORATED WITH

Transactions of the University of Toronto Engineering Society

DEVOTED TO THE INTERESTS OF ENGINEERING, ARCHITECTURE AND APPLIED CHEMISTRY AT THE UNIVERSITY OF TORONTO

Published every month in the year by the University of Toronto Engineering Society

EDITORIAL

CLASS OF '07 ANNUAL REUNION

About twenty members of the graduating class of 1907, Faculty of Applied Science and Engineering, University of Toronto, were in attendance at the annual reunion of the class held at the Engineers' Club on Tuesday evening, December 30th, 1913. The reunion was in the form of a dinner, Mr. A. D. LePan, president of the class, acting as toastmaster.

Many letters were read from absent members who sent their regards and best wishes for a very pleasant occasion, expressing the hope that the School would continue to prosper and turn out men of the '07 calibre. One letter, from a member of the class who was away on his honeymoon, brought in the subject of matrimony, and a careful survey of the year indicated that '07 men were not delinquent with respect to home-making.

The election of officers, as part of the evening's proceedings, resulted in the unanimous re-election of the president, Mr. A. D.

LePan, and the secretary-treasurer, Mr. A. A. Kinghorn, both of whom throughout the past year had filled their positions with adequacy and zeal.

After the meal had disappeared, the lounging room of the club was transformed into a veritable "round table" where a discussion ensued concerning the graduates, the School and the University. Several resolutions managed to take unto themselves concrete form, despite the intervention of "Litoria," "The Flowing Bowl," "Psalm of Life in S.P.S." etc., prompted by Clayton Bush who, when induced to furnish the music, did so in his usual generous manner.

The resolutions brought out a distinct expression of felling among the members of the Class that there should be a central organization in Toronto, consisting of representatives from each of the outside branches of the Engineering Alumni Association, to deal with matters concerning the graduates and their connection with the University on one hand and the engineering profession on the other. It was felt that the Toronto branch, as at present constituted, was not sufficiently in touch with branches outside of Toronto, and that more co-operation among them was needed. Several recommendations were adopted, to be forwarded to the secretary of the Toronto branch of the Engineering Alumni Association concerning the School and its graduates.

Taken altogether, the occasion was one that made up in enthusiism what it regrettably lacked in numbers. Many were the incidents of student days that were recalled, and the impromptu talks respecting the experience since graduation that materialized as the function progressed, were sufficient to show that '07 men have within themselves a vast share of the forces which attends all School functions of one kind and another.

Among those present were the following:—F. J. Anderson, Niagara Falls; C. E. Bush, Toronto; G. C. Cowper, Welland; F. R. Ewart, Toronto; G. R. S. Fleming, Toronto; T. H. Hogg, Toronto; L. G. Ireland, Brantford; A. A. Kinghorn, Toronto; A. D. LePan, Toronto; B. Neilly, Cobalt; R. B. Potter, Toronto; G. E. Quance, Delhi; A. C. T. Sheppard, Ottawa; W. Snaith, Toronto; G. F. Summers, Haileybury; H. W. Sutcliffe, New Liskeard; and P. M. Thompson, Toronto.

CAMPBELL-PICKARD

Mr. Chas. D. Campbell, '11, town engineer of Galt., Ont., was married on Tuesday, January 6th, 1914, to Miss Eva Pickard, of Galt. APFLIED SCIENCE extends heartiest congratulations.

THE "SCHOOL" DANCE

The annual At Home of the Engineering Society will be held in Columbus Hall on Friday evening, February 20th, from 8.15 until 1.30 o'clock. The executive are making every preparation to render this function a great success.

THE ENGINEER

Who comes with pencil sharpened keen,
With business air and sober mien,
With transit, level and what not,
And glittering axe the stake to swat?
The Engineer.

Who sets the transit, curves his spine,
Squints through the glass along the line,
Then waves his arms at frantic rate,
And yells: "Hell! hold that rod up straight!"
The Engineer.

Who raves and roars like one insane,
And claws the air and paws his mane,
Whene'er he sees a scraper take
A bite at his most cherished "stake"?
The Engineer.

Who swears he'll charge an "even ten"
For stakes destroyed by mules and men;
While on all fours he tries in vain
To find the vanished stake again?
The Engineer.

Who, speechless in his righteous rage,
Turns in hot haste the figured page;
And then, with gestures out of joint,
Ties in another "reference point"?
The Engineer.

Who calls it your "unrivalled gall"
Whene'er you kick for "overhaul,"
And gives your spine a wintry chill
Whene'er you spring an "extra" bill?
The Engineer.

Who deals in figures quite profuse,
Then tells you solid rock is loose;
That hard pan's nothing more than loam,
While gumbo's lighter than sea foam?
The Engineer.

And yet, in spite of all such ways,
Who is it that commands our praise,
While others harvest all the gain—
The golden sowing of his brain?
The Engineer.

The above poem, which was printed in the "Engineering News," in 1897, was recited at the last annual meeting of the Ottawa branch of the Canadian Society of Civil Engineers, and was well received.

DIRECTORY OF THE ALUMNI

A

Acres, H. G., '03, is associated with the Hydro Electric Power Commission, Toronto, as hydraulic engineer.

Adams, J. H., '10. His home address is 25 Maynard Ave., Toronto.

Adams, O. F., '10, is demonstrator in electrical engineering in the Faculty of Applied Science and Engineering, University of Toronto.

Aitken, J., '11, is assistant chemist for the Canada Cement Company in its manufacturing plant at Kilbourn Siding, Que.

Akers, H. G., '08, is a member of the firm of Akers, Mason & Bonnington, chemical engineers, Toronto.

Alexander, J. H., '04. His address is not known.

Alison, T. H., '92, is with the Bergen Point Iron Works, Bayonne, N.J., as chief engineer and secretary of the firm.

Alison, J. G. R., '03. His address is 50 Murray St., Toronto.

Allan, J. R., '92, is in Renfrew, Ont., carrying on a general engineering and surveying practice.

Allan, J. L., '00, is in Dartmouth, N.S., on Government service, as office engineer on the construction of a branch line from Dartmouth to Dean, N.S.

Allan, L. B., '11. His address is not known.

Allen, F. G., '07. We do not know his present address.

Allen, R. J., '13, is demonstrator in electrical engineering at the University of Toronto.

Allison, C. B., '08, is engaged in Dominion and Ontario land surveying. His address is South Woodslee, Ont.

Alport, F., '08. His present address is not known.

Amos, W. L., '06, is in the engineering department of the Hydro Electric Power Commission, Toronto.

Amsden, W. G., '10, is with the Consolidated Optical Co., Toronto.

Anderson, A. G., '92, is a hardware merchant at Port Dover, Ont.

Anderson, A. S., '13. His home address is 455 Hunter St., Peterboro, Ont.

Anderson, F. J., '07, is at Niagara Falls, Ont., with Anderson & Barry, engineers and surveyors.

Anderson, R. M., '08, is a member of the firm of Speight & Van Nostrand, engineers and surveyors, Toronto.

Andrewes, E., '97, is business manager for the Maenofferen Slate Quarry Co., of Portmadoc, North Wales.

Angus, H. H., '03, is on the staff of the Canadian Domestic Engineering Co., Toronto.

Angus, R. W., '94, is professor of mechanical engineering, University of Toronto.

Apsey, J. F., '88, has a practice as civil engineer in Baltimore, Md. His address is 3 N. Calvert St.

Archer, E. G., '11, is in the estimating department of the Hydro Electric Power Commission, Toronto.

Ardagh, A. G., '93, has a private practice in Barrie, Ont., land surveying and engineering.

Ardagh, E. G. R., '00, is lecturer in chemistry, University of Toronto.

Arens, A. H., '06, is resident engineer and mine surveyor for the Inverness (N.S.) Railway & Coal Co.

Arens, E. G., '09, is in Hamilton, Ont., with the Canadian Westinghouse Co., engineering department.

Arens, H. W., '03, deceased.

Arens, R. J., '08, is assistant superintendent of the Firestone Tire & Rubber Co., at Akron, Ohio.

Armer, J. C., '06, is manager of the *Canadian Manufacturer* Publishing Co., and secretary-treasurer of the Commercial Press, Limited, Toronto. He is president of the Engineering Alumni Association, Toronto Branch.

Armour, R. H., '05. His present address is not known.

Armstrong, H. V., '09, is at Estevan as resident engineer for Chipman & Power, Toronto.

Armstrong, J., '95, is chief engineer for the Hudson Bay Railway.

Ashbridge, W. T., '88. His address on our file is 1444 Queen St. E., Toronto.

Augustine, A. P., '07, is in Vancouver, B.C., and is engaged in land surveying.

Austin, E. T., '09, is in the employ of the Mond Nickel Co. at Coniston, Ont., as assistant engineer.

Avery, C. R., '13, is on the staff of the Provincial Board of Health at the experimental station on Clifford St., Toronto.

Aylesworth, C. B., '05, is with the Canadian Westinghouse Co. at Hamilton.

B

Badgley, L. A., '11, is a demonstrator in surveying, University of Toronto.

Bain, J. A., '00, is in Ottawa, as structural engineer, Department of Public Works.

Bain, J. W., '96, is associate professor of applied chemistry, University of Toronto.

Baird, J. A., '10, is in practice with his father in surveying and general engineering, Leamington, Ont.

Baird, W. J., '10, is Ontario and Dominion land surveyoi at Scarboro, Ont., and also is a demonstrator in surveying, University of Toronto.

Baker, M. H., '06, is city engineer for St. Thomas, Ont.

Baldwin, F. W., '06, is engaged with Graham Bell, Esq., Hammondsport, N.Y., and Baddeck, N.S., in experimentation and manufacture of aeroplanes.

Baldwin, L. C. M., '13. His address is Forest Hill Rd., Toronto.

Ball, E. F., '88, is chief assistant engineer of resurveys, N.Y.C. & H.R. R.R. Co., New York city.

Ballantyne, H. F., '93, is in New York, where he has for some years been carrying on an architectural practice at 2 West 47th Street.

Banting, E. W., '06, is a demonstrator in surveying, University of Toronto.

Barber, Frank, '06, is engineer for York county, and is carrying on a consulting practice in bridge and concrete engineering.

Barber, H. C., '08, is with the Packard Electric Co., Traders Bank Building, Toronto.

Barber, H. G., '02, is with the Department of the Interior, Topographical Surveys Branch, Ottawa.

Barber, T., '09, is hydraulic engineer for Chas. Barber & Sons, manufacturers of turbine water wheels and accessories, Meaford, Ont.

Barber, W., '05, is with the city of Toronto, in the roadways department.

Barker, H. F., '94, is in the city. He is a member of the firm of Godson Paving Co.

Barley, J. H., '00, is in the engineering department, Canadian Westinghouse Co., Hamilton, Ont.

Barnett, H. A., '10, is with the Canada Pacific Railway Co., construction department, Toronto.

Barrett, J. H., '04, is with the Wm. Davies Co., Limited, Toronto, as superintendent.

Barrett, R. H., '01, deceased.

Barry, W. H., '09, is a member of the firm Anderson & Barry, engineers and surveyors, Niagara Falls, Ont.

Bartlett, E., '08, is a member of the firm Bartlett & Grassie, engineers and surveyors, in Medicine Hat, Alta.

Bartley, T. H., '11, is in Mutana, Sask., engaged in Government resurvey work, under R. C. Purser, '06.

Bates, M., '06, deceased.

Batten, H. L., '11, is engineer for the Consolidated Mining & Smelting Co. of Canada Ltd., Traill, B.C., at their Centre Star Mine, Rossland, B.C.

Beatty, F. R., '07, is assistant manager of the architectural bronze and iron department of the Canada Foundry Co., Toronto.

Beatty, F. W., '13. His home address is Pembroke, Ont.

Beatty, H. J., '91, resides in Eganville, Ont., as an engineer and surveyor.

Beatty, J. A., '03, is a member of the firm of Morrow & Beatty, contractors, Peterboro, Ont.

Beatty, W. B., '13, is with the Topographical Survey Branch of the Department of the Interior at Ottawa, Ont.

Beauregard, A. T., '94, is now residing in Gravenhurst, Ont.

Beckstedt, R. D. S., '09, is superintendent and sales agent for the Tagonic Light & Power Co., Sault Ste. Marie, Ont.

Bedford, F. J., '08, is with the Dome Mines, Porcupine, Ont.

Begg, W. A., '05, is townsite inspector for the Department of Public Works at Regina.

Beith, R. E., '09, is in the employ of the Department of Public Works, Toronto.

Bell, C. A., '13, is with the Canada Copper Co., Copper Cliff, Ont.

Bell, G. G., '05. We do not know his present address.

Bell, R. S., '13. His address is 10 Starr Ave., Toronto.

Bellisle, J. P., '06, deceased, May, 1906.

Bennett, G. A., '09. His last address on our file is Tillsonburg, Ont.

Bergey, A. E., '94, is associate professor of constructive design in the Carnegie Institute of Technology, at Pittsburgh, Pa.

INDEX TO OUR ADVERTISEMENTS

Patronize Our Advertisers